Fisheries and Oceans Pêches et Océans

Newfoundland Region

DFO Science
Stock Status Report D2-01 (1999)

1998

# Newfoundland & Labrador Atlantic Salmon Stock Status

***Background***

*There are more than 200 rivers in Newfoundland and Labrador with anadromous Atlantic salmon populations. Each river is assumed to consist of at least one stock with larger rivers containing several stocks. There are 15 Atlantic salmon (Salmo salar L.) management areas known as Salmon Fishing Areas (SFAs) 1-14B in Newfoundland and Labrador (Fig. 1). Atlantic salmon exhibit a diverse life history including variations in time spent in freshwater, age at first spawning and duration and extent of ocean migrations. Spawning populations consist of varying proportions of small salmon (fork length less than 63 cm) and large salmon (fork length greater than or equal to 63 cm). The majority of rivers in insular Newfoundland primarily contain populations of small salmon or grilse which are maiden fish (never spawned before) that have spent one year at sea (1-sea-winter salmon) before returning to spawn. The majority of these fish are female. In the rivers of Labrador (SFAs 1, 2, & 14B), Bay St. George rivers (SFA 13) and Humber River (SFA 13), there are significant large salmon components which contain a mixture of maiden fish that have spent two or occasionally three winters at sea (2- or 3-sea-winter salmon) before spawning and repeat spawners which had spawned previously one or more times.*

*The majority of the maiden large salmon spawners are female. In other Newfoundland rivers, the large salmon component mainly consists of repeat spawners, only a few of which are maiden fish. The relative proportions of the size groups varies geographically.*

*Since 1992, there has been a moratorium on the commercial Atlantic salmon fishery in insular Newfoundland which was extended to all of Labrador in 1998. During the five-year interval prior to the moratorium (1987-91), the commercial fishery in insular Newfoundland took an average of 398 t or about 1[illegible] thousand salmon. In Labrador in 1997 which [illegible] the latest year of commercial fishing, landings were restricted by a quota of 50 t. Landings in 1997 were about 47 t or 12 thousand salmon. Also in 1992-97, there was a moratorium on the northern cod fishery, which would have eliminated salmon bycatches in cod fishing gear. The cod moratorium was extended to the south and west coasts in 1993. Cod fisheries reopened in 1997 on the south and west coasts of insular Newfoundland. It is still possible that salmon bound for Newfoundland and Labrador are caught in the small marine fisheries of Quebec, Greenland and St. Pierre-Miquelon.*

*The conservation requirements for Atlantic salmon rivers are considered to be threshold reference points. The consequences of egg depositions below conservation to the long-term sustainability of the stock are unknown but the likelihood of deleterious effects are greater when egg depositions are below conservation. The conservation requirements are established for individual rivers based on 2.4 eggs per $m^2$ of river rearing habitat and 368 or 105 eggs per hectare of lake habitat depending on the river system. The status of stocks is assessed on the basis of the proportion of the conservation egg deposition achieved in a given year and the trends in abundance of various life stages. It is recommended that no fishing be permitted on stocks that are below 100% of conservation requirements.*

November 1999

Canada

104-02227/

Map of Newfoundland and Labrador showing the locations of Salmon Fishing Areas 1-14B.

## *The Fisheries*

Atlantic salmon in Newfoundland and Labrador are potentially harvested by four user groups: Aboriginal communities, angling fishers, commercial outfitters, and commercial net fishers. Commercial net fishing was placed under a moratorium in insular Newfoundland in 1992, the Straits area of Labrador (SFA 14B), in 1997, and in southern (SFA 2) and northern Labrador (SFA 1) in 1998.

There was no Aboriginal food fishery at Conne River in 1998. This fishery had resumed in 1997 for the first time since 1993.

In 1998, approximately 16,000 salmon angling licenses (preliminary figure) were sold in Newfoundland and Labrador, a substantial decline from 1997 when 21,175 licenses were issued. Highest license sales occurred in 1988 at about 26,500. Mandatory barbless hooks were introduced to the angling fishery in the summer of 1998. Under this new regulation only barbless hooks or barbed hooks with the barb removed could be used. The purpose of this regulation was to minimize mortalities from hooking and releasing salmon. In 1998, management of angling fisheries consisted of five strategies depending on stock levels in individual rivers: 1) retention fisheries for small salmon in insular Newfoundland and the Straits area of Labrador (SFA 14B) with mandatory hook-and-release for large salmon, 2) quotas for small salmon on some rivers in Newfoundland, 3) retention fisheries for small and large salmon in northern (SFA 1) and southern (SFA 2) Labrador, 4) hook-and-release

fisheries for both small and large salmon, and 5) shortened seasons for retention fisheries on some rivers or in some cases complete closures. In-season reviews of stock levels were done for 19 rivers in insular Newfoundland.

Prior to 1997, angling data were collected by DFO River Guardians; however, in 1997 and 1998, catch and effort information for insular Newfoundland was derived from the License Stub Return System.

***Labrador***

Atlantic salmon in Labrador are legally harvested in Aboriginal communal food and angling fisheries (recreational and outfitting). Some salmon are caught as by-catches in charr/trout food fisheries and in commercial fisheries for other species. The Aboriginal food fishery in northern Labrador including Lake Melville recorded a catch of 14 t of salmon in 1998.

In 1998, the commercial fishery was closed in northern (SFA 1) and southern Labrador (SFA 2) due to anticipated low returns of salmon (especially large salmon) to Eastern Canadian rivers. There were 205 fishers licenced to fish salmon in 1997 who were affected by this closure. The commercial fishery in the Straits area (SFA 14B) was closed in 1997. There were 47 t of salmon caught in this fishery in 1997. In 1998, some of the salmon not caught due to the closure of the commercial fishery would have entered freshwater. Labrador origin salmon are also caught at Greenland as non-maturing 1-sea winter (1SW) salmon that would have returned to Labrador in the following year. Therefore, the Greenland catch in 1997 would have influenced the potential returns of large salmon to Labrador in 1998. About 4,300 salmon of Labrador origin were caught at Greenland in 1997.

The angling fishery in Labrador mainly occurs on rivers in coastal areas draining into the Labrador Sea and is pursued by guests at outfitting camps, both private and commercial, as well as by non-camp recreational fishers. Angling catch data for SFAs 1 and 2 are derived, as in previous years, from records kept by DFO River Guardians and log books from outfitting camps. For SFA 14B rivers, catch statistics for 1996-98 were derived from the License Stub Return System (the 1998 data are preliminary). The 1998 salmon angling fishery for all Labrador rivers opened on 20 June and closed on 13 September. Although retention of large salmon was allowed in SFAs 1 and 2, there was no retention of large salmon allowed for the entire season in SFA 14B. In SFAs 1 and 2, anglers could retain four salmon, one of which could be large, while in SFA 14B season limits similar to those for insular Newfoundland were in place (see below).

In 1998, the total Labrador angling catch was 7,371 fish, increasing by about 40% from 1997 and returning to levels similar to the pre-1993 period. The catch of small salmon was 6,377 (2,735 retained and 3,642 released) and large salmon was 994 (303 retained and 691 released) (Fig. 1). In SFA 1, the total catch (small and large salmon combined) of 874 increased over 1997 by about 75%. In SFA 2, the total catch of 4,499 increased over 1997 by about 40%. In SFA 14B, the total catch of 1,998 increased over 1997 by about 45%. The proportion of salmon released by anglers in Labrador, which has been increasing every year, was 59% of the total catch in 1998, the highest value recorded. In total, there were 4,333 small and large salmon reported to have been hooked and released in 1998.

### *Newfoundland*

At the opening of the angling season in 1998, there was a retention limit of one small salmon, pending the results of an in-season review. As a result of the in-season review, anglers were allowed to retain three additional small salmon from July 4 until the end of the season. There was no split season for retention of catch in 1998. In 1994-97, the season retention limit was three small salmon before July 31 and three after. Many rivers throughout the island were closed to angling, predominately in late July through August for 1-3 weeks, due to low water levels and high water temperatures, resulting in 13.7% of the

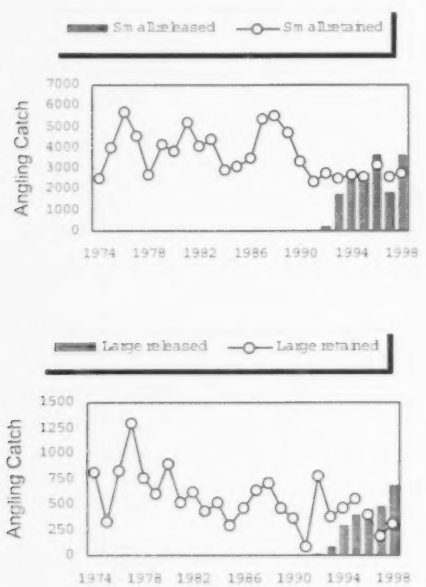


Figure 1. Angling catches of small and large salmon in Labrador SFAs 1, 2, & 14B, 1974-98. Data for 1996-98 are from the License Stub Return System for SFA 14B and DFO statistics for SFAs 1 & 2, 1994-98.

potential number of fishing days being lost. Some rivers or sections of rivers in Bay St. George were either closed to angling in 1998 or were restricted to hook-and-release fishing only, due to low stock levels. Three rivers were also closed in Bonavista Bay for conservation reasons. Some rivers were subject to special management measures and several had individual quotas.

A preliminary estimate of 30,883 small salmon (both retained and released) were angled in insular Newfoundland SFAs 3-14A in 1998, the lowest in recent years, a decline of 6% from 1997 and 23% from the 1992-96 mean, (Fig. 3). An estimated 2,853 large salmon were released, 14% lower than in 1997 but 44% higher than the mean for 1992-96. The proportion of hooked-and-released small salmon has increased every year since 1994.

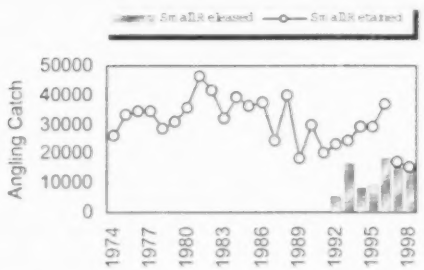


Figure 2. Angling catches of small salmon in Newfoundland SFAs 3-14A, 1974-98. Data for 1997-98 are from License Stub Return System and the 1998 data are preliminary.

## *Environmental Considerations*

Studies have shown that variability in ocean conditions influences both survival and growth of salmon as well as the timing and location of their migration. Similarly, conditions in freshwater influence growth, survival, length of residence in freshwater,

and timing of exit to the sea. On return as adults, migration and speed of upstream ascent are also influenced by water levels and temperatures. Exploitation rates on returning adults can also vary considerably depending on water level and temperature.

### *Marine*

In general, the below normal oceanographic trends in temperature and salinity, established in the late 1980's, reached a low in 1991, started to moderate during 1994 and were above normal by 1996. During 1997 and 1998, temperatures continued above normal over many areas, particularly on the Grand Bank during spring and over the deeper portions of the northeast Newfoundland Shelf. The main exception pertained to the near-shore coastal regions, in the upper-to mid-water column, where temperatures were colder than normal during summer and early fall.

Offshore in the mid-Labrador Sea, surface water temperatures remained average in the fall of 1997 but were higher than normal during the winter and spring of 1998.

In general, cold trends established in the late 1980s have moderated. The upward trend in temperature in the last two years may represent the return to more temperate marine conditions, which are favourable to salmon.

### *Freshwater*

Water conditions are summarized from monthly averages recorded at gauging stations at Eagle, Gander, Isle aux Morts, Rocky and Humber rivers. In Labrador, during 1998, water levels in May and September were higher than normal and slightly below normal in June but lower than normal in July and August. This is the reverse of 1997 when water levels in Labrador were higher than normal all summer. In insular Newfoundland, water levels on Gander River were below normal in May through August but very high in September. Isle aux Morts, Rocky and Humber rivers were somewhat lower than normal in May to June but higher than normal in July to September.

## *Resource Status*

### *Marine Survival*

Counts of smolts and resultant small salmon a year later, enable estimates of marine survival to be derived. Examination of survival trends over time can provide insight into effects of management measures designed to reduce marine exploitation, or, alternatively in the absence of fisheries, allow estimates of natural survival to be calculated. Counts of smolts also provide a direct measure of freshwater production, and in some cases, allow estimates of egg-to-smolt survival to be derived and evaluated in relation to current conservation requirements.

In Newfoundland, information on smolts and adult salmon counts is available from six rivers: Campbellton River (SFA 4); Northeast Brook, Trepassey (SFA 9); Rocky River (SFA 9); Conne River (SFA 11); Highlands River (SFA 13); and Western Arm Brook (SFA 14A). While the time series of available data varies among the rivers, each of the above has information that allows for direct comparisons back to at least the 1993 smolt class. Often, biological characteristic data are used to remove repeat spawning fish from the population estimates for small salmon. However, the following discussion uses comparable information for returns of small salmon only.

Northeast Coast Rivers

In Campbellton River, estimates of marine survival are available since the 1993 smolt class. During the 1993-95 period, survival to subsequent small salmon returns averaged 8.1%. The survival rate declined to 3.4% with the 1997 adult returns and was only 5.3% for small salmon returns in 1998 (Fig. 3).

South Coast Rivers

For Northeast Brook (Trepassey), a late run river, marine survival has also varied among years (Fig. 3). Peak survivals from the 1994 and 1995 smolt classes were in excess of 8 and 9%, respectively. Survival has declined to about 3% in 1997 and about 5% in 1998.

Rocky River is an enhanced stock. Fry stocking occurred from 1984 to 1987, and again in 1995 and 1996. In 1987, 140 adult salmon were also stocked. Marine survival averaged 3.5% from the 1990 to 1995 smolt classes, about 23% lower than that reported for Conne River. Marine survival has declined in each of the past two years falling to 2.5% for adult salmon returns in 1998. This was the lowest recorded to date.

For Conne River, estimates of marine survival have varied widely among years (Fig. 3). The highest survivals occurred with the 1987-89 smolt classes (7-10%), and again for returns in 1996 from the 1995 smolt class (7.2%). Survival from the 1996 smolt class fell to 3.4% but declined to 2.9% for returns of small salmon in 1998.

Southwest Coast Rivers

For Highlands River, counts of smolts and adult salmon are available from two time periods: 1980-82, and again since 1993. Highlands River is characterized by a run of two-sea-winter (2SW) salmon as well as a few 3SW fish. Marine survival from smolts to small salmon was less than 1% in the early 1980's, but increased to about 1.6% for the returns of small salmon in 1996 reaching a peak value of 3.2% for 1997 small salmon returns (Fig. 3). Returns of small salmon in 1998 coincided with the lowest marine survival rate obtained (1.4%) during the 1990's. Similarly, survival to large salmon returning in 1998 was also the lowest in recent years.

Northwest Coast Rivers

For Western Arm Brook, estimates of marine survival are available for 27 years. Survival has ranged from a low of 2.2% for small salmon returns in 1991, to a high of 12.1% for the 1979 returns (Fig. 3). In general, higher marine survivals have occurred subsequent to the closure of the fishery in 1992, but similar or even higher values have been obtained prior to the closure of the fisheries. It must be kept in mind that the above estimates of marine survival for years prior to 1992 have not been corrected for commercial exploitation. When corrected (Fig. 3) the difference between marine survival rates in pre- and post-1992 periods are even greater. Marine survival of small salmon which returned in 1998 increased substantially from the previous year but were still only 7.2%.

In summary, marine survival from smolts to returns of small salmon decreased in three of six cases in 1998 and were the lowest (Rocky and Highlands rivers) or second lowest (Conne River) values recorded. In those rivers where marine survival increased over the previous year (Northeast Brook (Trepassey), Campbellton River and Western Arm Brook), survival was still less than 10% and was either lower than past averages (Northeast and

Campbellton) or below values recorded previously when commercial fisheries were still in operation (Western Arm Brook). Thus, the phenomenon of high or above average natural mortality at sea that has been occurring throughout much of the 1990's continues and is of concern given the large-scale reductions in directed marine fishing mortality on this species.

### *Smolt Production*

In all six rivers, production of smolts in 1998 fell by 5.6% to 30.8% when compared with 1997 (Fig. 4). Smolt production at Highlands river was the lowest recorded and is anticipated to remain low until the year 2000, when the effects of the 1996 flood have ended. At Conne River, the number of smolts fell by almost 31%, but production was similar to the overall average over the past 10 years. It is noted that most of the smolts produced at Conne River in 1998 originated from the 1994 spawners which was the lowest spawning escapement observed. Also, at Conne River and at Northeast Brook (Trepassey), higher egg-to-smolt survival and smolt production coincided with years in which egg depositions were moderately low. Rocky River and Western Arm Brook also experienced greater than 25% declines in smolt production. With the exception of Rocky and Campbellton rivers, higher smolt production has been observed in the other rivers at some time prior to 1992 (before closure of commercial fisheries) than in 1998.

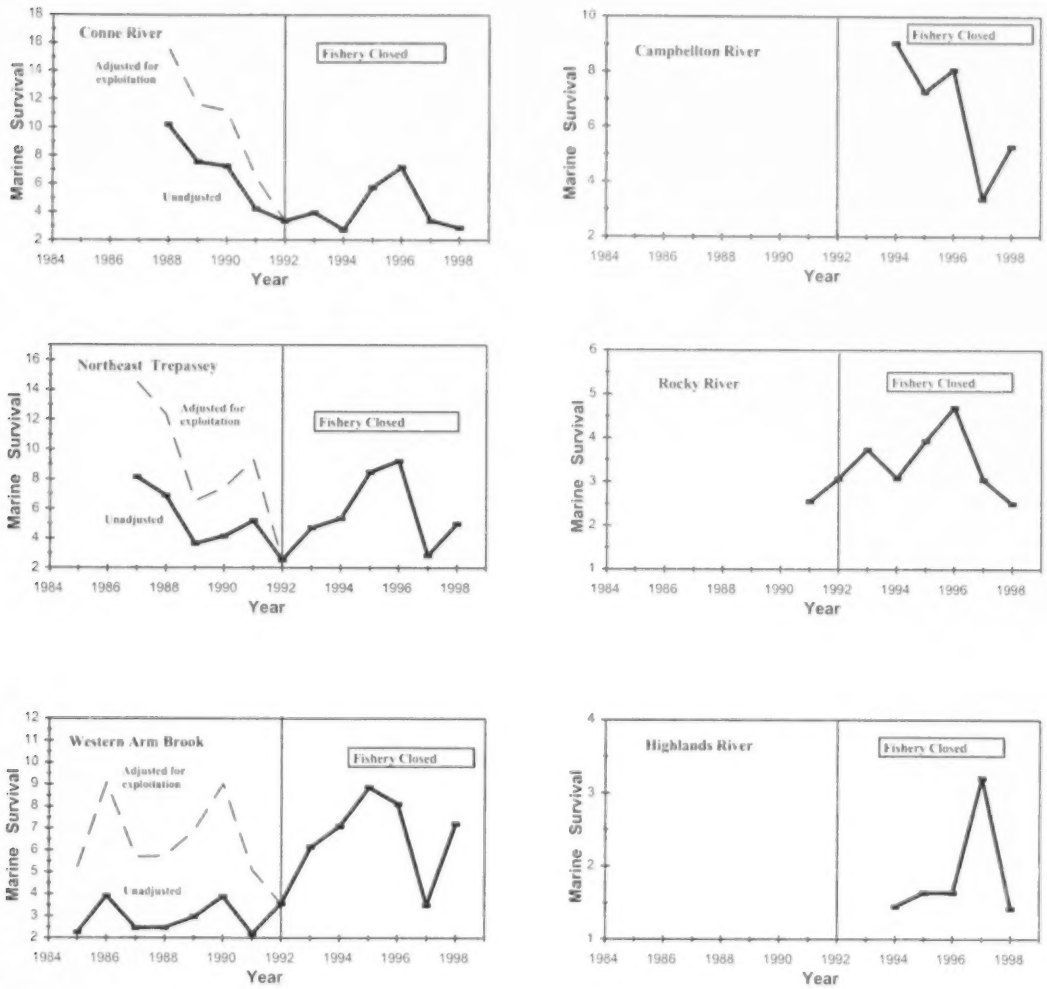


Figure 3. Marine survival rates for small salmon at Campbellton, Rocky, Highlands, and Conne rivers and Northeast and Western Arm brooks, 1985-98. Dashed lines illustrate survival rates adjusted for marine exploitation.

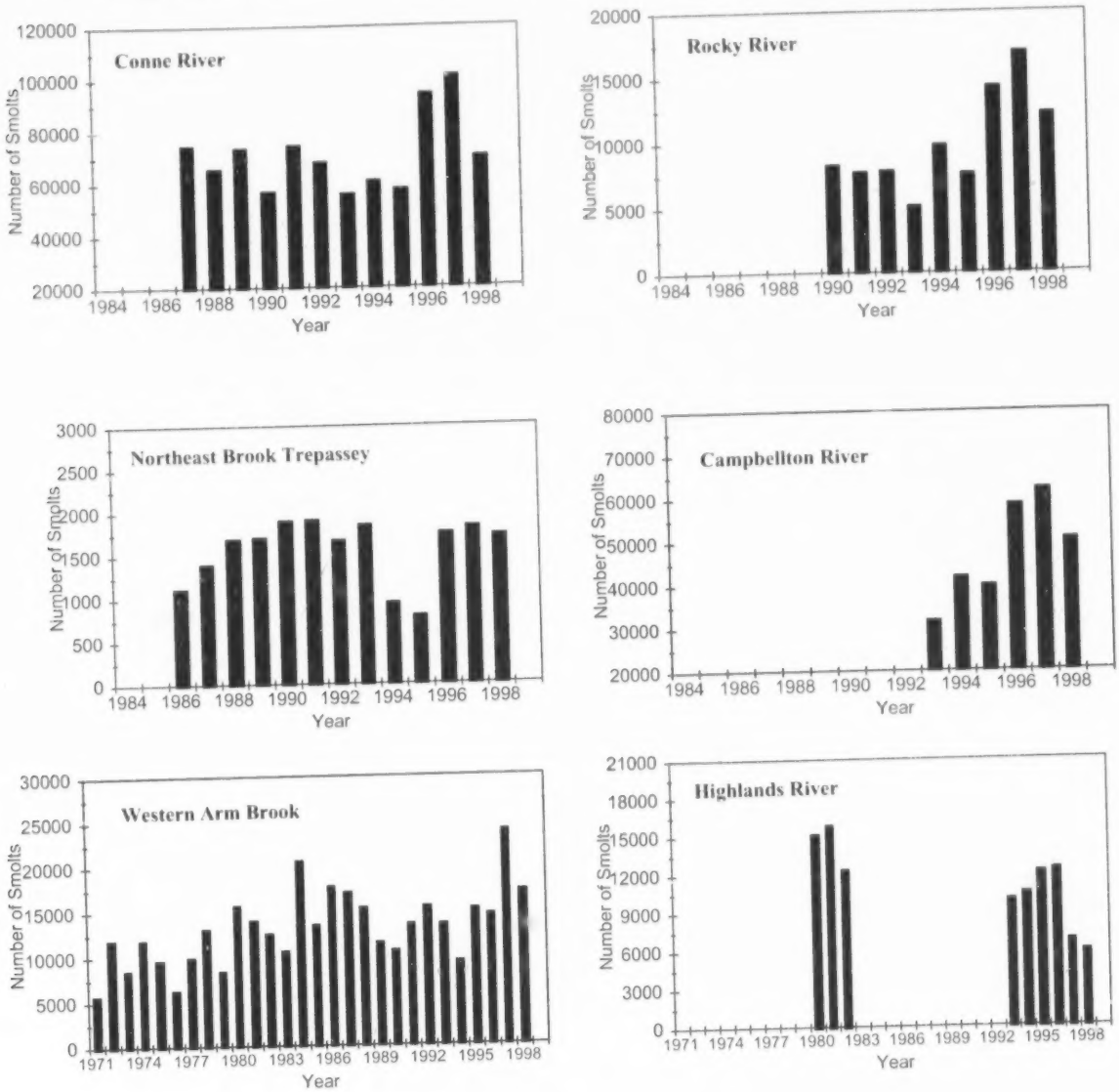


Figure 4. Smolt counts at Campbellton, Rocky, Highlands and Conne Rivers and Northeast and Western Arm Brooks.

## *Abundance of Adults*

During the commercial salmon fishery moratorium (1992-98), the numbers of small salmon returning to rivers in insular Newfoundland are considered to be the total number of salmon produced. The total abundance of adult salmon, in spite of increased returns to freshwater in the period 1992-96, remains low relative to abundance in the 1970s and 1980s when salmon which were caught in commercial fisheries prior to 1992 are added to the returns to rivers.

Abundance of salmon in 1998 can be examined relative to past returns to rivers. The returns are an indicator of potential spawning stock depending on the level of angling removals.

Returns of small salmon to some rivers on the north-west, north-east and east coasts in 1998, while generally improving over 1997 (Fig. 5), remained similar to or increased moderately over the mean for the moratorium years 1992-96, in spite of greatly increased spawning escapements beginning in 1992. Rivers in SFA 4 – Exploits, Campbellton, and Gander, SFA 5 – Middle, Terra Nova, and Northwest, and SFA 14A – Torrent and Western Arm increased from 2% to 238% in comparison with 1997, but only four out of these eight rivers increased in relation to the 1992-96 mean. With the exception of Northeast Brook (Trepassey) in SFA 9 and Northeast River (Placentia) in SFA 10, there was an overall decline in total returns of small salmon to rivers of the south and southwest coasts in 1998 compared to 1997. Rivers in SFA 11 – Little and Conne, and in SFA 13 – Highlands, Crabbes, Fischels, Pinchgut and Humber decreased from 3% to 76% in comparison with 1997. Two of these rivers also showed a decrease relative to the 1992-96 mean. For many rivers, returns in 1997 were the lowest since the commercial fishery closure began in 1992. While most of these rivers improved in 1998, there is still concern for salmon populations in SFAs 11, 12, and 13. The mortality associated with the severe flood in SFAs 12 and 13 in February 1996 is expected to keep the populations depressed in these areas for another one or two years. Despite the common pattern of annual fluctuations in abundance, there were some exceptions. Middle Brook (SFA 4), Northeast River (Placentia) (SFA 10) and Western Arm Brook (SFA 14A) have continued to show improvement in recent years.

Total returns of large salmon in 1998 exceeded those of 1997 for 11 out of 20 monitored rivers, while returns were similar to or declined from the 1997 levels in 9 rivers. The nine rivers were primarily in SFAs 5 and 13. Total returns of large salmon in 1998 exceeded the 1992-96 mean for 13 of 17 monitored rivers and were similar to or below the mean for four rivers. Although declines of small salmon to insular Newfoundland were noted on some rivers, returns of large salmon increased in most rivers to their highest levels since 1992. Some rivers that had decreased returns of small salmon in 1998 compared to 1997 still showed substantive increases in returns of large salmon (Rocky, Conne, Humber and Lomond).

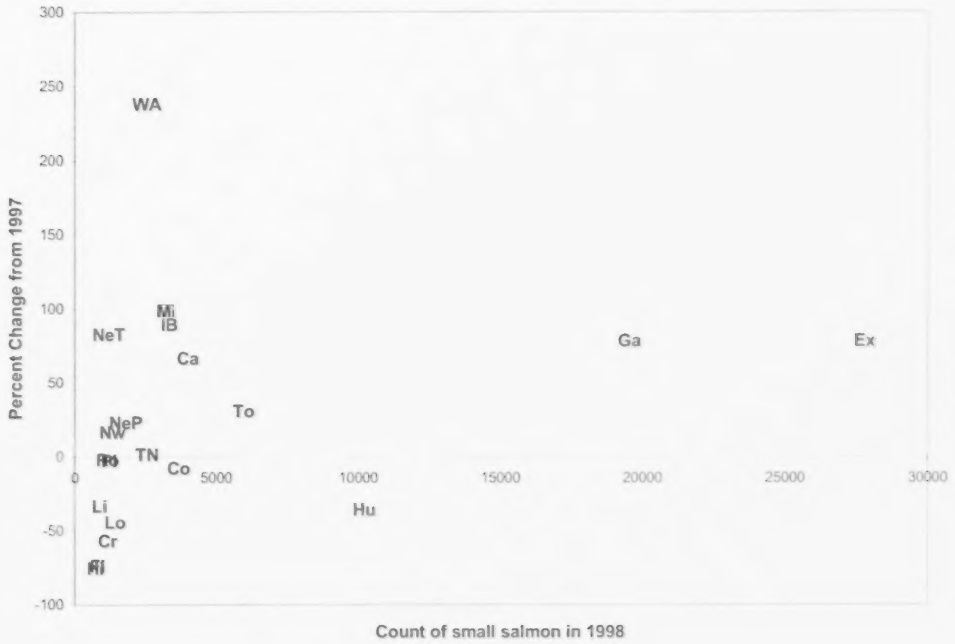


Figure 5. Percentage change in returns of small salmon to 20 monitored rivers in insular Newfoundland in 1998 compared to in 1997. River designations: Ca=Campbellton, Co=Conne, Cr=Crabbes, Ex=Exploits, Fi=Fischels, Ga=Gander, Hi=Highlands, Hu=Humber, IB=Indian Bay, Li=Little, Lo=Lomond, Mi=Middle, NeP=Northeast (Placentia), NeT=Northeast (Trepassey), Nw=Northwest, Pi=Pinchgut, Ro=Rocky, To=Torrent, TN=Terra Nova, and WA=Western Arm Brook.

It was not possible to determine the status of the salmon stocks in Labrador for 1998 due to the lack of in-river assessment programs. The available data suggest that angling catches and catch rates in SFAs 1, 2 and 14B were higher in 1998 than in 1997, but these are not reliable indicators of abundance without other corroborative data.

Water levels in most rivers in 1998 were near to or lower than average, whereas in 1997 water levels were considerably above average. Thus, angling conditions were much better in 1998 than in 1997 and should have resulted in higher angling catch rates. Higher catch rates observed in 1998 compared to 1997 could be related to improved catchability of salmon due to improved angling conditions, higher population size due to closure of the commercial fisheries, improved natural survival rates or a combination of these factors.

Analysis of data from a number of rivers indicates that in some cases, including Sand Hill River, there is no relationship between angling catch rates and numbers of salmon in the river. Thus, changes in angling catch rates are not necessarily indicative of changes in population size of salmon. However, inclusion of information on angling conditions such as the effects of varying water levels, which were not incorporated into the analysis, may improve the relationship. Notwithstanding the above points, angling catch rates and catches do not reflect an increase in population size to the extent that would have been expected with the closure of the commercial fisheries.

The total number of small salmon in insular Newfoundland in 1998 was estimated at about 190,000 (range of about 120,000 to 260,000). This is an increase of about 60% over the value in 1997; although in the time series from 1969 to 1998, there are numerous higher values indicating that 1998 values are not exceptionally high (Anon. 1999). For large salmon, estimates are 28,000 (range of 19,000 to 37,000). This is an increase of 70% from the previous year but is lower than in the mid-1980s.

## *Conservation Requirements*

The status of salmon stocks is assessed on the basis of the proportion of the conservation egg deposition achieved in a given year as shown in Figure 6. For Atlantic salmon rivers, conservation requirements are customized for each river depending on the amount of parr-rearing habitat available for salmon, which is developed from a physical survey of the river. The conservation requirements are based on 2.4 eggs per $m^2$ of river rearing habitat and 368 or 105 eggs per hectare of lake habitat depending on the river system (105 eggs per hectare is used for some northwest coast and Labrador rivers). The conservation requirements are considered to be a threshold reference point.

Of the 22 rivers (including 3 sub-sections for Exploits River) assessed for spawners and egg depositions, 10 (45%) achieved 100% or more of their conservation requirements in 1998 (Fig. 6). Conversely, 12 (55%) of the assessed rivers were below conservation requirements. Of the four assessed rivers in Bay St. George, none achieved conservation requirements in 1998, all having declined from 1997. Also, Humber River did not achieve its conservation requirements in 1998. Several of the assessed rivers along the northeast and south coasts met conservation requirements in 1998. Of those that did not meet their conservation

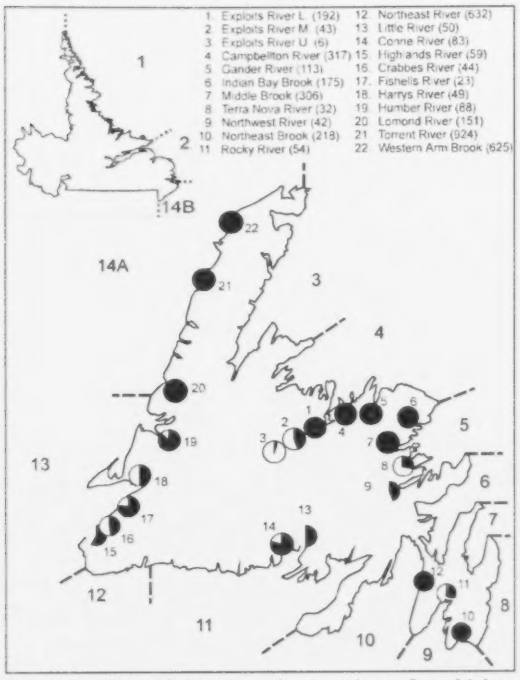


Figure 6. Map of rivers, or river sections, for which Atlantic salmon egg deposition in relation to conservation requirements was determined in Newfoundland and Labrador. The black portion of the circle and the number in parenthesis indicates the percentage of egg conservation requirement achieved for each river in 1998. For Conne River, the value shown is relative to the Management Target which is higher than the conservation requirement.

requirements in 1998, general improvements were noted over 1997.

An enhancement project was begun on Exploits River in the 1960s with the goal of introducing salmon to the middle and upper sections. While complete utilisation has yet to be achieved, the continuation of the present management regime should see this in the next decade or so. Thus, while the lower section achieved conservation requirements in 1998, the middle and upper portions of Exploits River remain considerably below conservation requirements.

All three assessed rivers on the northwest coast met conservation requirements in 1998.

There is no information on spawners and percent of conservation requirements achieved for Labrador rivers in 1998.

In summary, northwest and northeast coast salmon stocks appear to have improved the most over 1997 and since the moratorium on commercial salmon fishing while south and southwest coast rivers by and large have not.

## *Sources of Uncertainty*

Unlike the situation for many marine species, abundance and stock status of Atlantic salmon are for the most part based on near-to-absolute counts which reduces uncertainty considerably. In a few cases, abundance of smolts and adults is estimated using mark-recapture techniques. Even though estimates of egg deposition are accurate, resultant smolt production can be highly variable and unpredictable. Similarly, smolt-to-adult survival is highly variable and over time several predictive relationships have failed. There is also a lack of current data on sex ratios, sizes and fecundity of large salmon in spawning escapements in Newfoundland and Labrador. Although the majority of spawners are small salmon, for which good data are available, better biological characteristics data for large salmon would reduce uncertainty from the large salmon spawners.

In recent years, the License Stub Return System has become the main source of angling data for stock assessment purposes. This system is still evolving and relies heavily on the co-operation of anglers to maximise the precision of estimates of catch

and effort. Currently, the return rate of angling logs is around 50%, far short of the desired 90%. Even though angling catch rates are often used as indices of salmon abundance, analyses from certain rivers with counting facilities have shown no relationship between catch rates and abundance.

Exploitation rates based on angling catches are sometimes used to estimate total returns and spawning escapements for rivers without counting facilities. Where possible exploitation rates for such rivers are calibrated with those of a nearby indicator river with a counting facility. However, such estimates are confounded by differences among rivers in factors affecting catchability and variability in number of angling days resulting from changes in management measures due to environmental conditions or in some cases low stock levels.

Angling catches have a direct role in salmon assessments because total returns minus the angling catch, including 10% mortality on hook-and-released salmon, provide estimates of spawners. Spawners are used to determine egg deposition and the percent of conservation requirements met. Thus, if catches are actually higher than estimated from the License Stub Return System, then spawners are over estimated. Conversely, if catches are lower than estimated spawners are under estimated.

Good angling catch and effort information is of paramount importance to assessing the status of salmon populations, evaluating the effectiveness of management plans, and provision of sound management advice. There is still uncertainty about the estimates of angling catch and effort statistics as derived from the angler Licence Stub Return System, and its comparability to historical data collected through the River Guardian System. It is important that efforts continue to improve the return rate of licence stubs and to validate the information from the stubs through creel census. Estimates of total returns of salmon to monitored rivers require the annual collection of angling data below fish counting facilities.

### *Research Recommendations*

As pointed out above, Atlantic salmon populations are characterized by annual fluctuations in abundance, which at times, can be quite dramatic. Both density-dependent and density-independent processes can contribute to this variability. In order to determine the status of stocks and understand how fish populations respond to exploitation, and to implement management strategies to ensure conservation levels are achieved, accurate information on stock abundance is required. These data are also required to update and refine current conservation spawning requirements and to develop river-specific stock-recruitment relationships.

The most accurate means by which to obtain these data are from fish counting facilities.

In addition, counts of smolts and adult salmon enable estimates of marine survival to be derived.

While the reasons for the varying marine survival may be difficult to explain in the absence of an intensive marine program, the marine survival rates when viewed for trends are especially valuable for management and the general public.

Specific recommendations are as follows:

1. At a minimum, all fish counting facilities and mark-recapture programs in operation during 1998 should be

continued in 1999 and maintained in subsequent years. These projects form the long-term core data for providing stock assessment advice. Given the apparent lack of response in south coast Newfoundland stocks to the commercial salmon fishery moratorium, consideration should be given to resuming fish counting fence operations at Biscay Bay River (SFA 9) and other locations. Also, the addition of smolt monitoring in the Northeast Placentia system would be worthwhile.

2. Salmon stocks in Bay St. George, SFA 13, are characterized by rivers with virgin 2SW and 3SW components. Stock problems still exist in this area. Visual spawner surveys and fish counting facilities at Highlands and Pinchgut rivers should be maintained and consideration given to establishing an additional index fence site on an early run stock.

3. Humber River is believed to have a fall run of large and possibly multi-sea winter (MSW) salmon that presumably spawns in the lower part of the river. Investigations should be initiated to substantiate and quantify the importance of this stock component to the overall Humber River salmon population.

4. There is some evidence for density-dependent processes influencing salmon production in several Newfoundland stocks. Relationships should be updated in the context of further refinements to river-specific conservation spawning requirements, and where information exists, other stocks should be examined in the same context.

5. Studies initiated in 1998 to document, and address the impact of predation by cod and sea birds on migrating salmon smolts should continue in 1999 and, if feasible, be expanded to other locations. Similarly, studies should be carried out to investigate seal predation on salmon during periods when salmon smolts are migrating.

6. Concern has been expressed about the effect of hook-and-release fishing practices on salmon mortality and especially on estimates of spawners and conservation requirements achieved. Given the limitations of past experiments and their near absence in Newfoundland and Labrador, appropriate experiments should be designed and projects carried out to address, the valid concerns expressed by the general public related to hook-and-release.

7. Fish counting facilities are required for Atlantic salmon stocks in Labrador where there are currently none.

8. Concern has been expressed about potential impacts on wild salmonid stocks as a result of the apparent large numbers of escaped farmed salmonids in Bay d'Espoir this past fall and winter. A series of monitoring programs should be implemented to document the distribution and relative abundance of escaped farmed fish in Conne River and adjacent watersheds and continued in subsequent years. This would provide a means by which the implementation of updated containment practices in the aquaculture industry are monitored and furnish baseline information from which to examine potential impacts on wild fish populations.

9. As for other species, harvest and effort statistics are vital to resource

management of Atlantic salmon. These data provide a means for evaluating the effectiveness of management measures and for assessing the status of stocks. The Licence Stub Return System implemented in 1994 has the potential to be a consistent and reliable method of data collection. It is recommended that development of this system continue through improvements such as verification with other methods and by increasing angler response.

## *Outlook*

### *Short-term*

Stock-specific forecasts for 1999 salmon returns were not made. The smolt output from all monitored rivers was lower than in 1997, however, it was above the 1992-1997 mean output. If sea survival remains similar to 1998, the return of smolt salmon in 1999 will be slightly lower than in 1998. However, if sea survival improves, returning to pre-moratorium levels, then returns of small salmon will be very good for insular Newfoundland. With respect to Labrador, salmon returns in 1999 will be from some of the lowest egg depositions on record.

With respect to MSW salmon in Bay St. George, egg depositions were low in 1993 and severe flooding occurred during the winter of 1996, conditions which warrant caution with respect to 1999 returns. While egg depositions have been increasing in many rivers, survival rates for the 1997 smolt class were among the lowest recorded to date, with 2 of 6 monitored facilities recording the lowest values in the time series. The latter was particularly true for SFA's 9-13. Continuing lower marine survival will reduce future returns.

### *Long-term*

In insular Newfoundland, the number of spawners has been relatively high in recent years due to the closure of the commercial fishery. Natural mortality rates in freshwater and marine environments will continue to play a major role in determining population sizes. Without an increase in marine survival rates, adult salmon populations will not increase. The returns of salmon to Bay St. George rivers are not expected to increase dramatically until the influence of the flood in 1996 on juvenile levels have ended.

For Labrador salmon, increased numbers of large salmon are not expected until the year 2000, assuming that sea survival remains at or above the 1997 level. Also, the proportion of total recruits that mature as large salmon must remain constant or at least not decline.

## *Management Considerations*

It is recommended that no fishing be permitted on stocks that are below 100% of conservation requirement.

It was not possible to determine the status of the salmon stocks in Labrador for 1998 due to the lack of in-river assessment programs. In addition, information from Sand Hill River suggests that angler catch and catch rates are not reliable indicators of abundance without other corroborative data. Based on previous estimates of spawning stock size, it is not expected that populations will increase substantially in 1999 in Labrador without an improvement in natural survival rates. It is not possible to evaluate the benefits to the spawning stock from the closure of the commercial fishery in 1998.

There is a requirement for in-river monitoring facilities in Labrador to determine changes in the population size, which may have increased subsequent to the closure of the commercial fisheries. The catch of salmon in the food fishery in SFA 1 (Northern Labrador) was quantified in 1998; however, estimates are also required for SFA 2 (Southern Labrador).

It is recommended that the management target for the Exploits River be increased from 13,000 to 18,000 small salmon (as recommended in SSR D2-03 (1998)). The Exploits River requires about 57,000 salmon to meet its conservation requirements; average returns to the river from 1992 to 1996 were about 20,000 fish. In 1998, in excess of 26,000 small salmon returned to the river. Since this river remains in the developmental stage, due to past enhancement programs, it would be appropriate to increase the management target in 5 or 6-year intervals, equivalent to a life cycle.

There are no concerns regarding the fall hook-and-release fishery on the Gander River in September, provided that conservation requirements are met. If mortality is high, it may result in over exploitation of a possible localized stock in the lower section of the River.

There are still conservation concerns regarding the size of the salmon populations in Northwest River (Port Blandford), Southwest Brook (Port Blandford), and Salmon Brook (Port Blandford) in SFA 5.

Particular consideration should be given to the conservation needs of the salmon populations in SFAs 11, 12, and 13. The spawning populations in most Bay St. George rivers appear to be very low. The mortality associated with the severe flood in SFAs 12 and 13 in February 1996 is expected to keep populations depressed in these areas for another one or two years. Restrictive management measures should continue on these stocks, and no fisheries should be permitted on Fischells Brook. Poaching on some rivers such as Harrys River, Flat Bay Brook, and Fischells Brook are believed to be long-standing problems hampering stock recovery. It is also suspected that loss of fish habitat may also be a factor in the slow recovery of these populations.

The salmon population in the Lower Humber River should be managed as a unique stock, because of the apparent later timing of the run to this section of the river, and the contribution of a small number of 3SW salmon to the population. The low catch rate in the fall fishery in 1998 is consistent with a low population size, although catch rates are also influenced by factors other than population size. A cautious approach should be taken in managing this fishery to ensure survival of this sub-stock.

Some rivers in SFA 14A have returns in excess of their conservation requirements; thus, there is an opportunity for increased harvest. A controlled fishery could be permitted on Western Arm Brook, whereby, about 100 salmon could be angled for scientific purposes under an Experimental Permit. Western Arm Brook is one of the few rivers in the Province with good stock and recruitment data, which may eventually provide for recommendations to alter conservation requirements. Thus, it is important that there be strict control of the number of salmon angled. Angling should be confined to the lower section of the river to ensure accurate catch records, and all salmon should be sampled for weight, length, sex, and age determination.

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ISSN 1480-4913 (for English series)
ISSN 1480-4921 (for French series)

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